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DEPARTMENT OF ANATOMY
SCHOOL OF MEDICINE
THE CENTER FOR THE HEALTH SCIENCES
LOS ANGELES, CALIFORNIA 90024

May 30, 1973

Mr. Robert P. Gow
President
Develco, Inc.
530 Logue Avenue
Mountain View, California 94040

Dear Bob:

I am responding to your letter of May 24, and to the enclosed draft of your gneeral letter of proposal. As indicated in your draft, I had promised an overview of our work relevant to this proposal, and I apologize for my remissness in not sending it to you sooner.

Let me first set a structural and functional frame for the brain and central nervous system which will be brief enough yet sufficiently explicit to allow interpretation of what follows by any competent communications engineer. This is a frame that has grown up in great degree from our own research. It will thus have a strong color attributable to our group, and in some degree will be nonclassical, and will still lack acceptance by some prestigious neurobiologists. Nevertheless, there is an increasing body of opinion from respected leaders in neurobiological research, particularly those involved in molecular biology and neurochemistry, who see the need for a substantial updating in our accepted view of brain organization. This latter view is now appearing because of the increasing tide of observations on brain organization for which classical explanations are inadequate.

First, a functional sensitivity of the human central nervous system has been demonstrated in several laboratories to very weak electric fields in air where these fields are oscillating at brain wave frequencies. The strength of the fields is of the order of 25 mV per centimeter and the effects include altered reaction times, altered subjective estimates of the passage of time, and alterations in daily body rhythms, including body temperature cycles and sleep/wakefulness cycles. Part of this work has been done in our laboratory. We have also tested the effects of VHF fields with the same electric intensity. In animals, these fields are potent in modifying states of sleep and wakefulness, and in modifying specific internal brain rhythms that represent or are associated with behavioral responses. The VHF field studies showed an absence of effect with unmodulated fields, and selective effects with different modulating frequencies between 3 and 16 Hz.

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The emphasis on these functional interactions has to be in terms of their very weak strength. For example, the total current induced by the low-frequency fields in the head of the monkey is slightly less than 1 nanoampere. If we compare the electric gradient in the tissue with that producing actual synaptic depolarization, it is almost 11 orders of magnitude less. For these reasons, classical synaptic physiology cannot be adduced as an explanation for these phenomena.

For that reason, much molecular biology and biophysical research has been directed to possible ways in which nerve cells may sense changes in their environment, without invoking classical theories of synaptic activation. It is feasible that the surface of nerve cell membranes may act as transducers for extremely weak chemical and electrical influences through the sensitivity of a charged sheet of glue-like molecules covering the cell surface. Such a role has already been proven for sensitivity to hormones and drugs that alter nerve cell action in extremely small concentrations. This is the most radical aspect of the changed anatomy and physiology now being hypothesized and tested to explain these interactions.

I turn now to the future, from the viewpoint that these preliminary studies indicate a feasibility to manipulate and control brain states by modification of the environmental electromagnetic "atmosphere". First, a long range research program is much needed to specify in much greater degree than has been possible to date the precise mode of itneraction of the nerve cell with these weak environmental influences. There is thus a very important class of problems in the biophysics of membrane transducing. A second and equally important class of problems concerns the way in which groups of nerve cells may interact with each other so that their summed behavior is modified by such weak influences. Both classes of process, molecular on the one hand and as a neuronal population characteristic on the other, probably involve interactions classed as "cooperative" in the terminology of physicists. Work in this area is only beginning in terms of biological models and in evaluation of biological interactions. Progress will be slow but the significance is so great that a program of this kind should be framed to allow at least 5 years of concerted effort with relatively few fruits of a "reportable" kind in the initial years. This point must be emphasized in an age when short-term rewards are almost a sine qua non for the program manager. On the other hand, it should be emphasized that promoters of this program are not seeking a fishing license just to pursue a dilétante interest.

From the foregoing, it seems clear that there are possibilities for a whole range of modulations and modifications of human behavioral patterns, based on the interactions with a wide variety of environmental fields. To

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this time, work has focused on quite simplistic aspects of carrier frequency selection and on equally simple modulation patterns that have been selected on a quite arbitrary basis within the spectrum of none brain wave activity. We may anticipate a substantive increase in capability through carefully planned research on frequency selections. The outcome is likely to be an optimizing of states of attention with increased learning capability, or the reduction in levels of awareness, and in induction of sleep states. It is highly likely that this type of manipulation can have therapeutic significance in achieving desired changes in widespread medical problems, such as insomnia and endocrine disorders, such as menstrual irregularity.

Less clear to me at this time, but perhaps no less feasible, will be detection of bioelectric and biomagnetic phenomena at a distance from the subject without the need for contact electrodes. Already, work in cryomagnetometry has yielded important new capabilities in monitoring heart and brain function. Within the established theoretical sensitivity of the Josephson junction technique lie many physiological parameters from which an assessment of subject status may well be possible. Current research in this field has been limited by the funding available for research in the needed instrumentation. Until basic laboratory techniques have been well enough evaluated, little or nothing can be done in development of instrumentation for field use. Also in the forefront of serious problems for the method currently is its susceptibility to environmental electrical magnetic pollution. Much will surely be done if funding is available to improve the differential's sensitivity to the important biological signals.

Again, in this prospective view of needed monitoring instrumentation, is the prospect that advances will be slow and the needed effort must be extremely dedicated if we are to succeed at all. Yet I have no doubt that these goals can be achieved if adequate support is forthcoming.

I hope that this overview, though lengthy, will give you a perspective on what I genuinely believe to be possible as the next step in highly important medical monitoring systems. Their social significance is likely to eclipse all previous developments in medical instrumentation. The time to begin is now and progress will surely be slow. I hope that these opinions will assist you in completing your documentation.

With my best regards.

Sincerely,

W. Ross Adey

W. Ross Adey, M. D.

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